

**Limiting Reagent Lab:
The Reaction Between Vinegar and Baking Soda**

Goal: During this lab students will gain a quantitative understanding of limiting reagents.

Safety:

- Safety goggles should be worn at all times.
- Students should hold the balloons on the test tubes tightly while the reaction takes place.

Procedure

1. Students need to get together in teams of four students.

2. Students need to follow the directions below:

Student A: Weigh the following six amounts of baking soda (sodium bicarbonate, NaHCO_3): 0.18 grams, 0.35 grams, 0.52 grams, 0.70 grams, 1.00 grams, and 1.70 grams.

Student B: Label the balloons 1-6. Put the six different masses of baking soda into six balloons using a small plastic funnel. Make sure the baking soda goes to the bottom of the balloon.

Student C: Using the graduated cylinder and pipet, accurately measure and transfer 10.0 mL vinegar (5% acetic acid, $\text{HC}_2\text{H}_3\text{O}_2$) into each of the 6 test tubes.

Student D: Attach the filled balloons to the mouth of the test tubes. Make sure that the contents of the balloon and test tube are not mixed.

3. Before mixing the contents of the balloons and test tubes, make a prediction about which combination will produce the greatest amount of carbon dioxide gas.

Prediction: _____

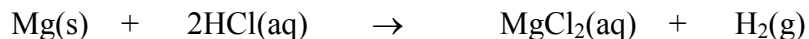
4. After the balloons are securely attached to the test tubes, each group member needs to lift a balloon on one of the test tubes so that the contents of the balloon mix with the test tube contents. **Make sure the balloons are held on tightly to the test tube.** All six test tubes should be reacted simultaneously. When the reactions are done, record your results in the table on page 4.

Results: Rank the test tubes in order of least to greatest amount of carbon dioxide gas (CO_2) produced.

Postlab: Answer the following and complete the table on page 4.

1. Write the balanced molecular equation for the reaction that takes place during this lab. What is the identity of the gas that inflated the balloons?
2. Find the number of moles of baking soda (NaHCO_3) used in each reaction: ($\text{NaHCO}_3 = 84.0 \text{ g/mole}$)
3. What is the true combining mole ratio of acetic acid to sodium bicarbonate for the reaction?
4. Determine the mole ratio of sodium bicarbonate to acetic acid for each reaction. (There are 8.3×10^{-3} moles of acetic acid in 10.0 mL of acetic acid.)
5. Looking at your mole ratios in number 4, identify the chemical that was in excess in each test tube. Which chemical was the limiting reactant in each test tube?

6. Consider the following reaction:



(a) What is the combining mole ratio of Mg to HCl?

(b) Suppose this reaction is performed similarly to the acetic acid/baking soda reaction. A volume of HCl is put in the test tube and a mass of Mg metal is placed in the balloon. Hydrogen gas is produced and inflates the balloon. Which balloon will be the largest? Complete the following table: (There are 0.0100 mol of HCl in 10.0 mL of HCl; Mg = 24.3 g/mole).

Test Tube #	Mass of Mg, g	Moles of Mg	Volume of HCl, mL	Moles of HCl	Mole ratio Mg:HCl	Excess Reagent	Limiting Reagent
1	0.122		10.0				
2	0.500		10.0				
3	0.100		10.0				

Name _____

Test Tube #	Mass of NaHCO_3	Moles of NaHCO_3	Volume of acid, mL	Moles of acetic acid	Mole ratio: NaHCO_3 : acetic acid	Excess Reagent	Limiting Reagent
1	0.18 g		10.0				
2	0.35 g		10.0				
3	0.52 g		10.0				
4	0.70 g		10.0				
5	1.00 g		10.0				
6	1.70 g		10.0				

Name _____